Smart Sensors I

Group 164

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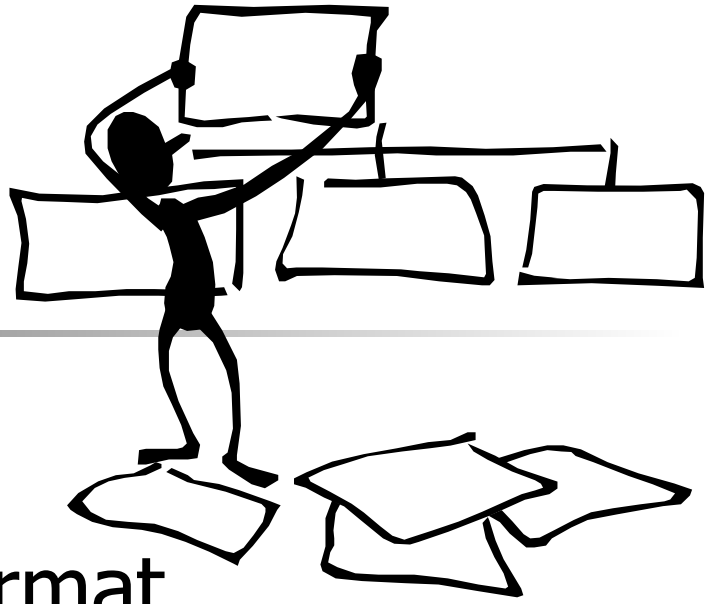
Final Presentation

Outline



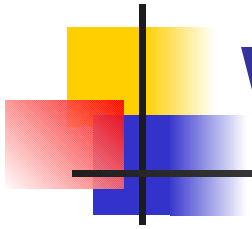
- Overview
- Network/Protocol Format
- Node Specs
- Base Unit Specs
- User Interface
- Risk Assessment
- Future Work

Objectives

- Develop an inexpensive ad hoc multi-node wireless temperature monitor
- Incorporate a portable base unit to increase user mobility
- Include computer aided data analysis
- Warn user of temperatures outside preset range

Application

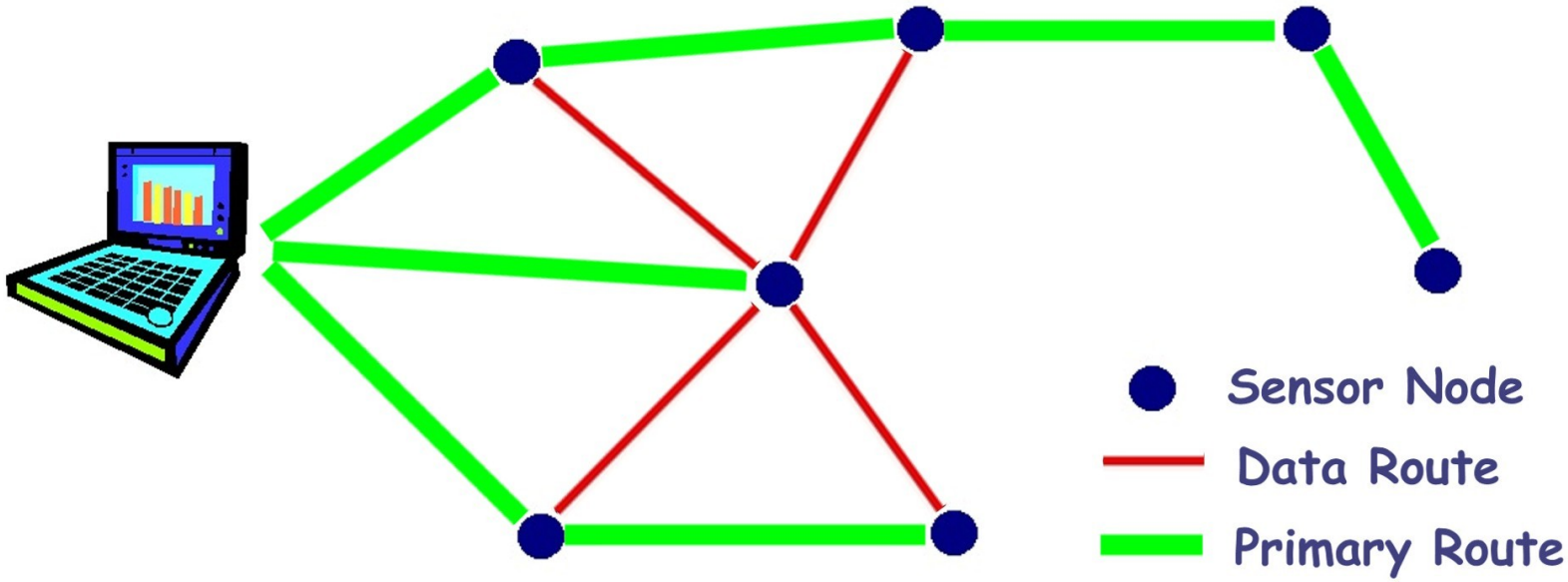
- Food Safety
  - Food storage and transportation
- Ensure proper temperature levels to reduce or prevent bacterial growth and maintain food quality
- Protect customers' well-being and reduce food waste caused by improper cooling

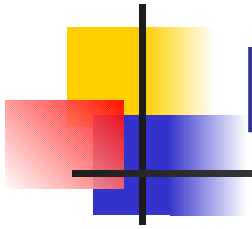


Why ad hoc?

- Data is relayed between nodes to allow short range transmitters to communicate long distances
- Conserves power by reducing transmitter size and range
- Accommodates varied and changing network layouts

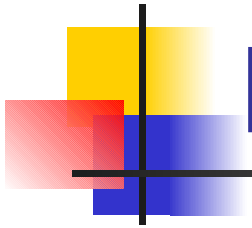
Network Structure





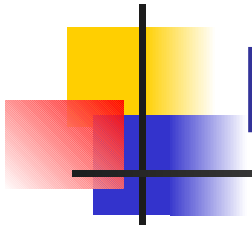
Protocol Format

- A customized protocol has been developed for the network
- Two distinct packet types required for ad hoc operation
  - **Route Discovery** – *Identifies routes*
  - **Route Aware** – *Utilizes discovered routes*



Route Aware

- If a route to a node is available, a Route Aware packet is used to communicate with the node by using the route information to find the node
  - Quickest way to communicate
  - Only passes through nodes in the direct path to the desired node
  - Conserves power in the network

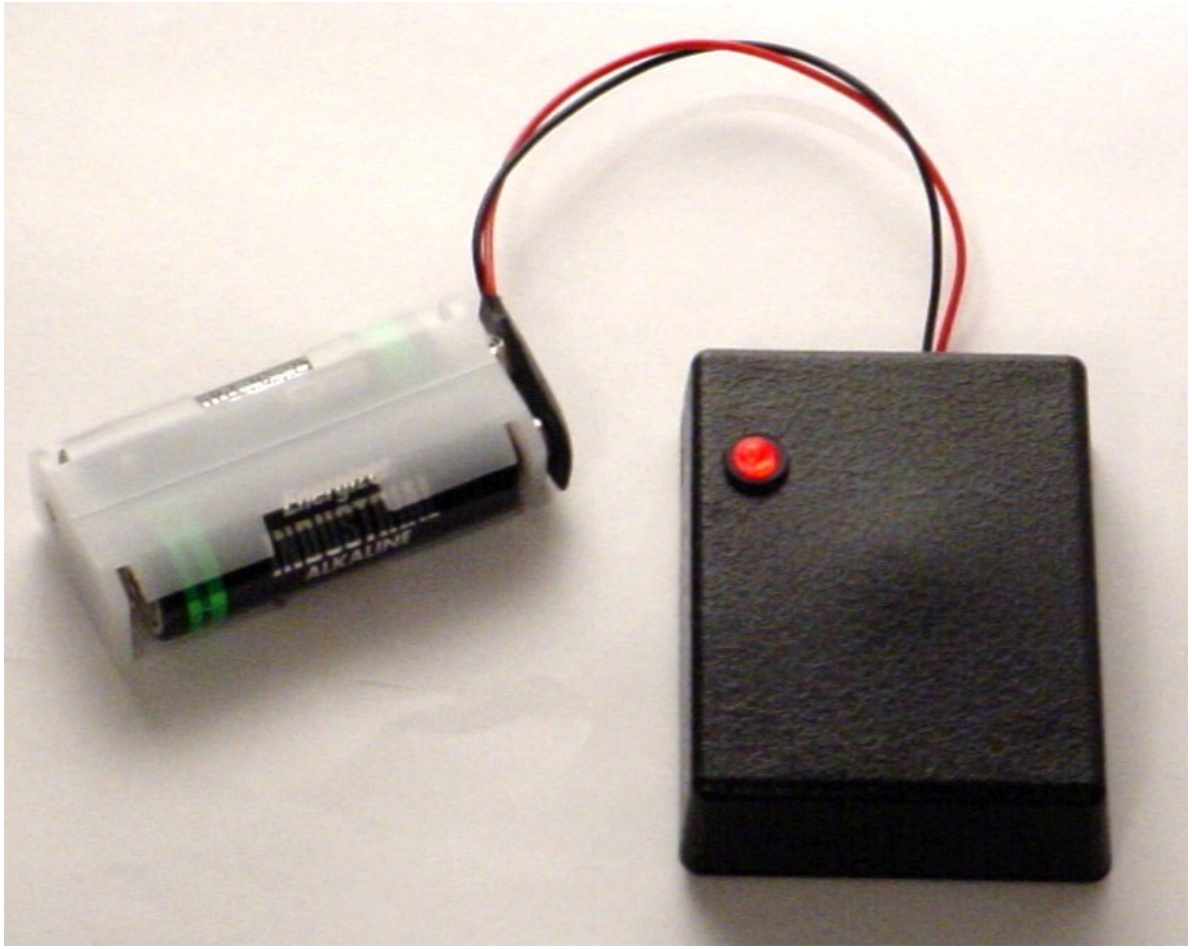


Route Discovery

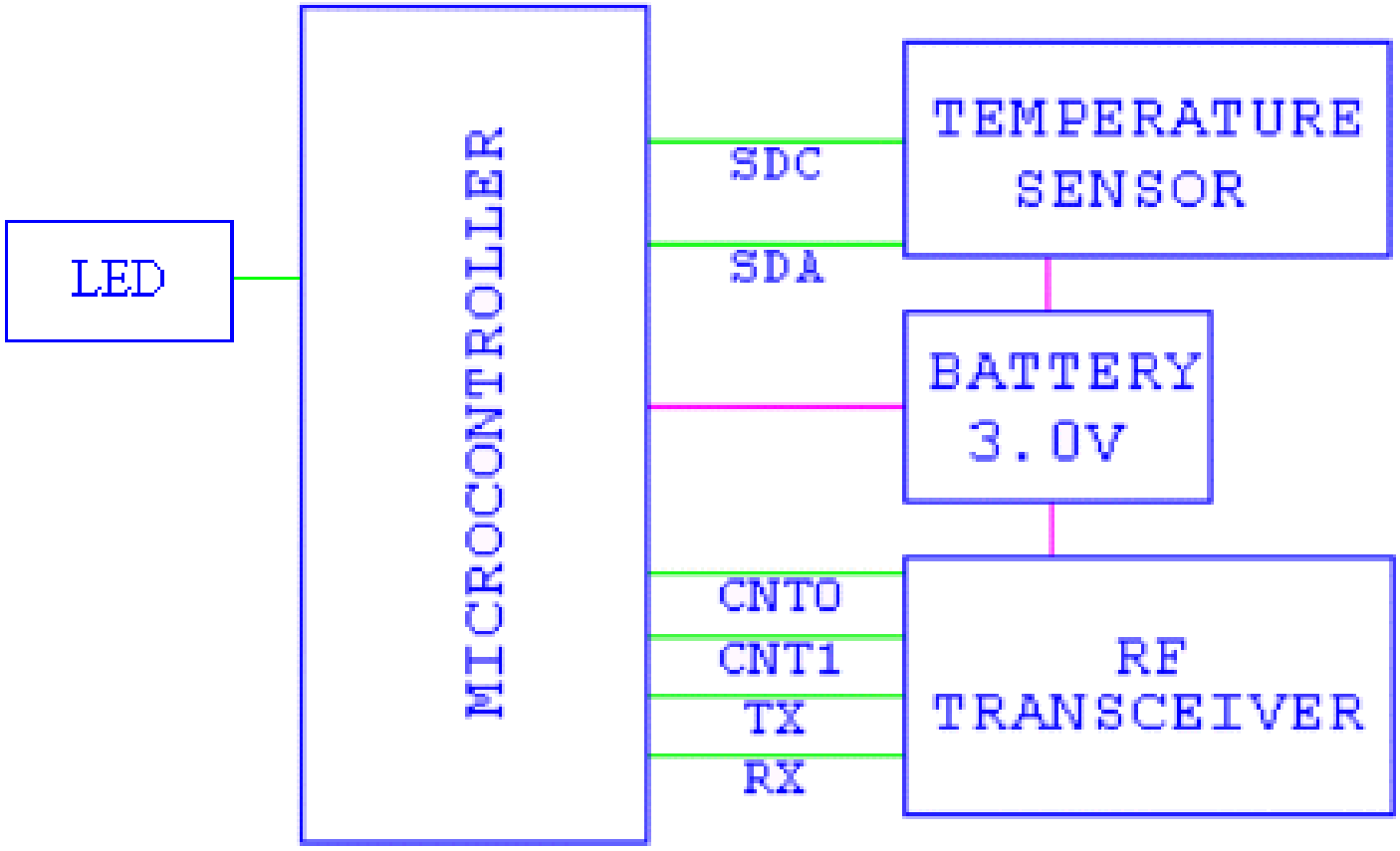
- If a route to node is unknown, a Route Discovery packet is used to find the quickest route possible
  - Packet propagates through the entire network
  - Builds a route table from the nodes it passes through
- Upon reception at the desired node, a Route Aware packet is sent back to the Base Unit using the route information obtained.
- The Base Unit stores the route contained in the Route Aware packet for future use

General Packet Format

Sensor Node



Node Block Diagram



Node Specs

- Uses 16LF628 microcontroller
  - Smaller 18 pin package saves space
- DR3000 transceiver – 916 MHz
- New DS1631 temp sensor used
  - Improved accuracy over existing sensors
- LED is included to indicate when radio transmissions are made

Node Specs II

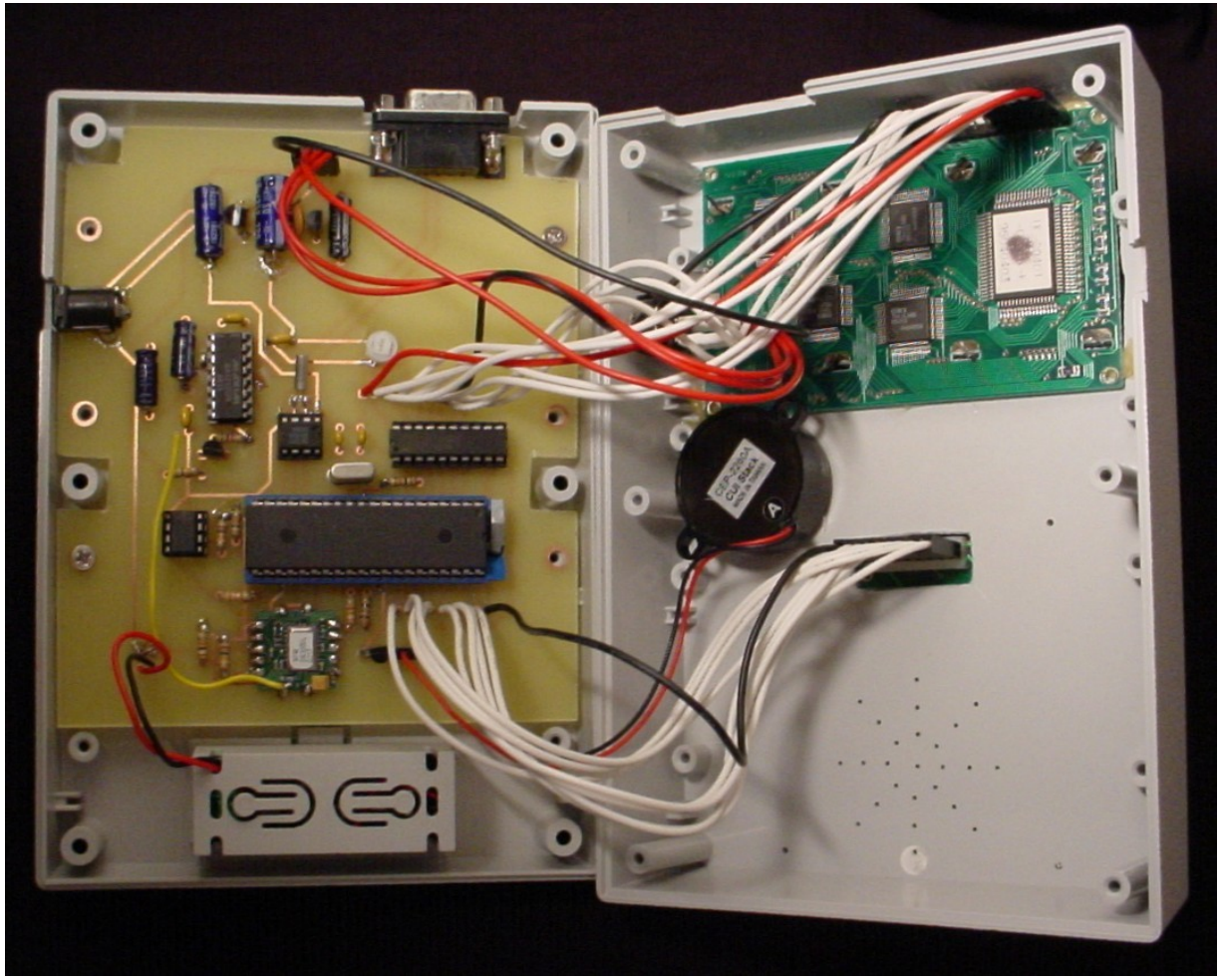
- Entire circuit operates on 3-volts
  - 2 AA batteries
- Battery Life
  - Constant use with LED: 13 days
  - Constant use with no LED: 19.5 days

Base Unit

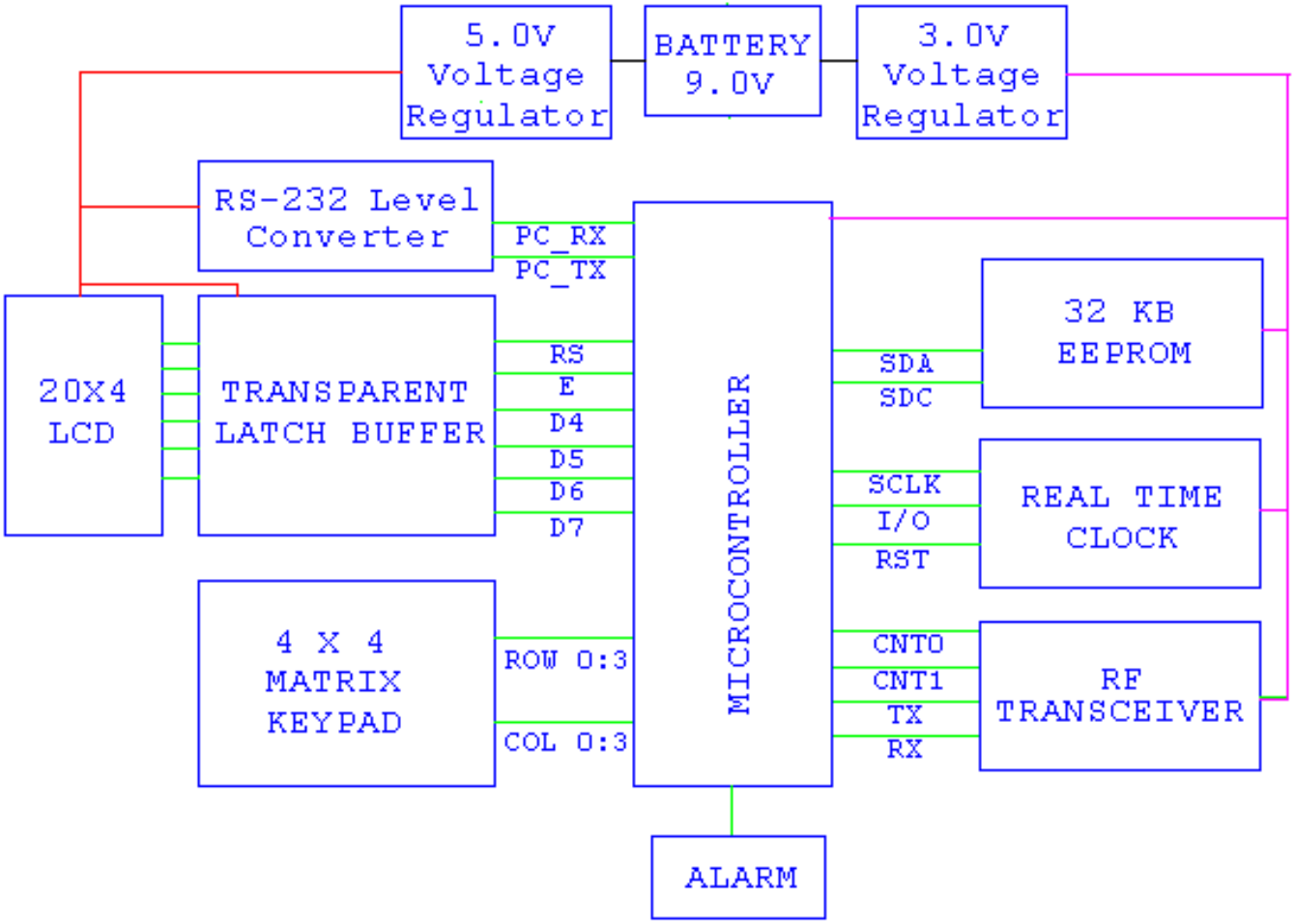
- Base unit is handheld and portable
- LCD display for data output
- 4x4 keypad for user inputs
- Computer connection
  - Computer aided analysis

Base Unit

Base Unit Circuit



Base Unit Block Diagram



Base Unit Specs

- Powered by a 9 volt battery or DC adapter
- Battery Life
  - Base Unit OFF: 140 days
  - Base Unit ON: 3 days
- Connects to computer at 19.2 kbps via serial cable
- Uses EEPROM to store collected data

Base Unit Specs II

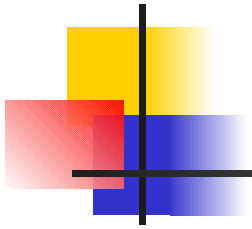
- Incorporated PIC16F877 microcontroller running at near memory capacity
- 5-volt dc buzzer included for alarm
- Real time clock chip included to enhance data analysis
- External EEPROM used to expand memory capacity of Base Unit

Base Unit Specs III

- Microcontroller, EEPROM, real time clock, and transceiver operate on 3-volts to conserve power
- MAX232, LCD, buzzer, and transparent latch operate at 5-volts to meet required part specs
  - Transparent latch used to convert voltage levels between microcontroller and LCD

Base Unit Menu

- 1. Node Temp
- 2. Start Collection
- 3. View Data
- 4. Connect
- 5. Set Clock
- 6. Temp Alarm Range
- 7. Delete All Memory



1. Node Temp

- Polls a single node for its temperature
- Requested temperature will be displayed on the LCD
- Reading will not be stored in memory
- “Communication Failure” will be displayed on LCD if requested node did not return a temperature

2. Temp Collection

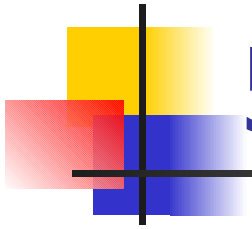
- Allows several nodes to be polled on scheduled intervals
- Received temps. will be stored in memory along with the time of arrival
- Most recent temp. to be received will be displayed on the LCD
- If a received temp. is outside the acceptable limits, the alarm will turn on
- Polling interval can be set anywhere from one second to every 256 minutes

3. View Data

- Allows all temperatures and times collected during scheduled collection to be viewed on the LCD
- User selects an individual node's data to view
- Large amounts of data can be scrolled through using the arrow keys

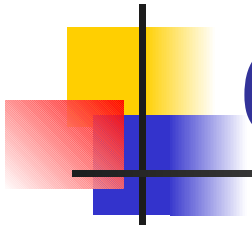
4. Connect

- Connects the Base Unit to a computer via a serial cable
- All Functions of the Base Unit will be controlled by the computer until the user exits the routine



5. Set Clock

- Allows the user to read and set the real time clock on the base unit
- Both date and time functions are available
- Real time clock is responsible for determining when temps are received during a scheduled collection



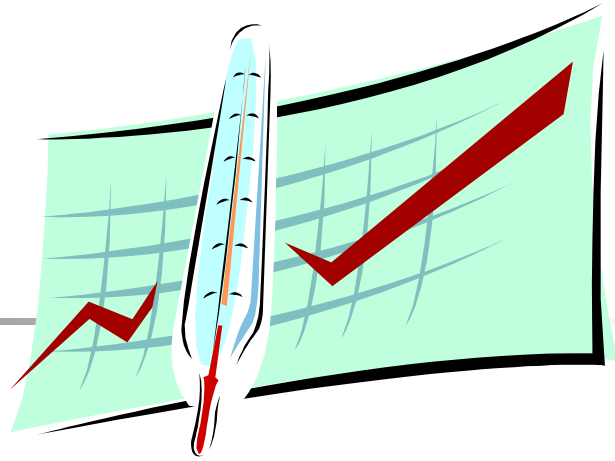
6. Temp Alarm Range

- Allows user to view and set the acceptable range of temperatures during scheduled collection
- Temperature can be set in one degree Celsius increments

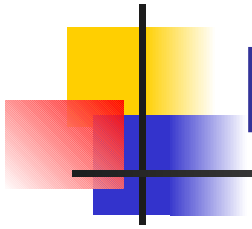
7. Delete All Memory

- Deletes the readings stored during scheduled collection from the Base Unit's memory
- This is the only way to delete readings

Data Analysis

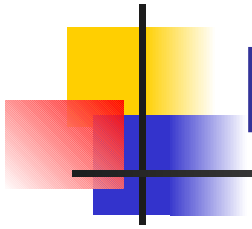


- Data can be stored and viewed on the Base Unit
- Data can be downloaded to a computer to be manipulated and saved as desired
  - Graph temperature trends
  - Print data
  - View routes and network structure



Risk Assessment

- Packet Collisions
  - Random delays are incorporated during RD to prevent multiple nodes from transmitting at the same time
  - Several attempts are made to establish communication in case a packet gets lost
- Code complexity
  - Hardware UART buffer used to handle incoming packets



Future Work

- Noise filtering circuitry would increase transmission distance and network reliability
- Rather than polling network, sensors could return temperatures periodically automatically

Questions/Comments